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Latitudinal Psychology: An Ecological Perspective on Creativity, Aggression, Happiness, and Beyond

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Abstract

Are there systematic trends around the world in levels of creativity, aggressiveness, life satisfaction, individualism, trust, and suicidality? This article suggests a new field, latitudinal psychology, that delineates differences in such culturally shared features along northern and southern rather than eastern and western locations. In addition to geographical, ecological, and other explanations, we offer three metric foundations of latitudinal variations: *replicability* (latitudinal gradient repeatability across hemispheres), *reversibility* (north-south gradient reversal near the equator), and *gradient strength* (degree of replicability and reversibility). We show that aggressiveness decreases whereas creativity, life satisfaction, and individualism increase as one moves closer to either the North or South Pole. We also discuss the replicability, reversibility, and gradient strength of (a) temperatures and rainfall as remote predictors and (b) pathogen prevalence, national wealth, population density, and income inequality as more proximate predictors of latitudinal gradients in human functioning. Preliminary analyses suggest that cultural and psychological diversity often need to be partially understood in terms of latitudinal variations in integrated exposure to climate-induced demands and wealth-based resources. We conclude with broader implications, emphasizing the importance of north-south replications in samples that are not from Western, educated, industrialized, rich, and democratic (WEIRD) societies.

Keywords

latitudinal psychology, northern location, southern location, CLASH, climatoeconomic theory, pathogen prevalence, WEIRD psychology

The vast majority of psychological science is based on studies conducted in North America and Europe (Henrich, Heine, & Norenzayan, 2010). With the increase in international exchanges, the rapid development of cross-cultural psychology, and the availability of “big data,” it is safe to predict that psychology is bound to become less local and more global. How is one to describe and interpret the findings coming from all over the world? Here we attempt to address this scientific puzzle by asking whether there is an underlying or overarching reality with profound influences on cultural and psychological diversity. Inspired by the numerous and well-documented latitudinal gradients in plants and animals (Chown & Gaston, 2000; Fincher & Thornhill, 2008; Harcourt, 2015; Millington, Blumler, & Schickhoff, 2012; Rosenzweig & Sandlin, 1997), we propose the importance of latitudinal gradients in human functioning. Specifically, we conceptually and empirically relate

latitude to ecological conditions that underlie differences in broad cultural features such as creativity, aggressiveness, life satisfaction, and individualism.

Of course, geographic latitude as such has no direct psychological relevance. Latitude does, however, refer to locations with considerable variations in thermal climate, including a greater disease burden and greater poverty in warmer climates, which do have a direct impact on livability and human functioning. It would therefore come as no surprise if psychologists were to pay close attention to why and how humans navigate between too much cold and too much heat: satisfying

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basic needs of thermal comfort, nutrition, and health; being reluctant to settle down in arctic regions at high latitudes or in desert regions at low latitudes, where livability is problematic; and creating cultural practices and artifacts to thrive in cold winters and hot summers. But that is not the case. Indeed, there is a paucity of research into human adaptations to frigid and hot atmospheric environments.

Hence, we seek to make a connection between thermal climate and psychology, asking many broad and intriguing questions. For example, how sure are we that violent aggression (Van Lange, Rinderu, & Bushman, 2017a) and subjective well-being (Fischer & Van de Vliert, 2011) as cultural adaptations to thermal climate do not deserve a more prominent place in psychology? How important is it to know that specific genes interact with extreme cold and heat in producing interpersonal trust and cooperation (Kong, 2016)? Does finding out why inhabitants of more challenging thermal habitats appear more inventive, innovative, and otherwise creative (Karwowski & Lebuda, 2013; Van de Vliert & Murray, 2018) deserve priority over other issues? These questions are clearly too numerous and voluminous to be successfully addressed in a single article. Therefore, we more realistically aim to inspire colleagues to develop interdisciplinary research programs that will lead to a better understanding of the connections between climate, culture, and psychology.

Focusing on latitudinal gradients, we pursue five specific purposes. First, we provide a typology of possible explanations for why north-south differences would dwarf east-west differences in human functioning. Second, we identify some key characteristics of latitudinal variations that help evaluate which ecological factors might partially influence human functioning in contemporary societies. Third, using these characteristics of latitudinality, we report systematic evidence of latitudinal differences in creativity, aggressiveness, life satisfaction, individualism, trust, and suicidality. Fourth, to illuminate potential explanations, we explore the extent to which climate-induced demands and wealth-based resources may interact to help explain these latitude-related differences in cultural features. Finally, we close by outlining long-term implications of this perspective and forecasting a distal yet promising role for thermal climate in accounting for many phenomena in psychology textbooks.

Before continuing, we introduce a label for the long-term ambition to explain variations of psychological phenomena along the north-south rather than east-west axis of the Earth. *Latitudinal psychology* is guided by the observations that the Earth (a) has North and South Poles but no “East and West Poles,” (b) creates opposite

north-south conditions in the Northern and Southern Hemispheres; (c) causes all plants and animals, including pathogens, to navigate latitudinally between too much cold and too much heat; and (d) requires especially humans, who feed on plants and animals and avoid pathogens, to adapt to conditions of cold winters, hot summers, or both (Richerson & Boyd, 2008; Van de Vliert, 2016; Van Lange et al., 2017a). Our latitudinal perspective is ecological in that it concentrates on how individuals and groups adapt to physical, biological, and economic environments, which are inevitably conditioned by thermal climate.

Latitudinal psychology differs from other psychologies with a spatial touch. Perhaps the most striking difference is the larger territorial scale, covering the mind-sets and behavioral habits of human inhabitants of every habitat on Earth (for symmetry across scale, see Gelfand, Harrington, & Jackson, 2017). Latitudinal psychology anchors evolutionary psychology (e.g., Buss, 2011; Kenrick, 2012), and especially the framework of evoked culture (Gangestad, Haselton, & Buss, 2006), to the North and South Poles and to the seasonal patterns of solar radiation to which all warm-blooded species adapt. It broadens extant research in ecological psychology (for overviews, see Oishi, 2014; Varnum & Grossmann, 2017) by emphasizing north-south differences in environmental pressures at a global scale. Latitudinal psychology also informs geographical psychology (Rentfrow, 2014; Rentfrow & Jokela, 2016), as it relates mental and behavioral phenomena to the varying locations and conditions along the north-south axis above and below the equator.

Explaining Latitudinality in Human Functioning

Most psychologists now agree that culture matters for broad features such as creativity, aggressiveness, happiness, and individualism. However, there is not much knowledge about why these cultural features are so unevenly distributed around the globe, how they are interrelated, and, ultimately, how that may help us to understand their roots. By adopting a strongly ecological perspective, latitudinal psychology seeks to break new ground while illuminating these issues. We contribute conceptual descriptions and general predictions as first building blocks for latitudinal psychology, starting out with four possible explanations of latitudinal gradients in mind-sets and behavioral habits. Table 1 roughly organizes these preliminary geographical, ecological, evolutionary, and contemporary explanations into a two-by-two typology of context (spatial, temporal) by nearness (distal, proximal), and we discuss them in that order.

Table 1. Spatial and Temporal Explanations as Theoretical Foundations of Latitudinal Psychology

Typology of explanations	Theoretical foundations	Central psychological tenets
Spatial context		
Geographical explanation	Human biogeography	Inhabitants' habits are dependent on habitat location
Ecological explanation	Climatoeconomic theory	Thermal demands are compensated for by resources
Temporal context		
Evolutionary explanation	Life-history theory	Environments elicit trade-offs in personal investments
Contemporary explanation	Compensatory-control theory	People restore reduced control over their environment

Geographical explanation

Theories of human biogeography (e.g., Harcourt, 2015) assert that no plant, no animal, and certainly no human being feeding on plants and animals is immune to the impact of the Sun on how life unfolds. All carbon-based life forms are by axiom dependent on the Sun's radiation for meeting energy needs to survive and thrive. Because of the Earth's rotation, the amount of solar energy that reaches any given location varies by latitude and negligibly by longitude. Relatedly, geographical explanations of survival and reproduction in nonhuman species emphasize the importance of latitudinal gradients over longitude-related variations (Chown & Gaston, 2000; Fincher & Thornhill, 2008; Harcourt, 2015; Millington et al., 2012; Rosenzweig, 1995; Rosenzweig & Sandlin, 1997). Human societies also seem to vary along latitude while being similar along longitude (Diamond, 1997; Laitin, Moortgat, & Robinson, 2012). For example, the 62 largest empires in history tended to expand less along the north-south axis than along the east-west axis of the Earth. (Turchin, Adams, & Hall, 2006).

Despite this biogeographic knowledge, until recently (Jonason & Schmitt, 2017; Ronen & Shenkar, 2013, 2017; Roscoe, 2017; Van de Vliert & Daan, 2017; Van Lange et al., 2017a, 2017b), latitude-related accounts of human functioning have been virtually absent in what psychologists profess about mind-sets and behavioral habits. One could argue that Daniel Nettle (1998, 1999; see also Cashdan, 2001; Fincher & Thornhill, 2008) laid the first cornerstone of latitudinal psychology when he demonstrated that, just like biodiversity in plants and animals, language diversity in humans tends to decrease at higher latitudes. Opponents, however, could counter that the number of languages spoken per standard area is hardly a psychologically meaningful factor and that there is more latitudinal psychology in the thermoregulatory-based adaptation of using more consonants (such as *b*, *g*, *k*, *p*, and *t*) at

colder latitudes but more vowels (such as *a*, *o*, *u*, *ie*, and *ee*) at hotter latitudes (Fought, Munroe, Fought, & Good, 2004; Van de Vliert, 2009).

To date, only one study has used both latitude and longitude to test whether human inhabitants' habits are dependent on their habitat location (Van de Vliert & Conway, 2019). Across 228 independent countries and dependent territories, in-group favoritism, out-group rejection, political oppression, legal discrimination, and communication bullying appear to vary with latitude but not with longitude. Overall, the common factor of conflict-prone intergroup discrimination varies from north to south both above the equator, $r(125) = .46$, $p < .001$, and below the equator, $r(54) = -.41$, $p < .001$, but is invariant from east to west both right, $r(145) = .06$, n.s., and left, $r(79) = -.08$, n.s., of the Greenwich meridian. The strength that this study used both obtrusive and unobtrusive measures came with the weakness that it was restricted to contemporary culture influenced by relatively recent patterns of migration, colonization, and globalization. Therefore, in a later section with tests of the geographical explanation, we address that weakness by using an unobtrusive measure of cultural individualism in the precolonial and preindustrial societies of the Old World.

Ecological explanation

Biologists often specify geographic understandings of plant and animal life by proposing explanations in terms of climatic demands (e.g., cold, heat, drought, deluge) and local resources (e.g., soil quality and available nutrition). Latitude-related intergroup discrimination has been accounted for isomorphically in terms of climatic demands and the availability of wealth resources to cope with these demands (Van de Vliert, 2009, 2013a; Van de Vliert & Conway, 2019). The central climatoeconomic propositions are that (a) higher climatic demands are appraised as more threatening by poorer people but as more challenging by richer people; (b) poor people's threat

appraisals activate survival- and prevention-oriented goals that increase collectivism, hierarchism, and discrimination while decreasing creativity and happiness; and (c) rich people's challenge appraisals activate growth and self-expression goals that decrease collectivism, hierarchism, and discrimination while increasing creativity and happiness.

This demands-resources theory disregards climatic determinism as well as economic development as the primary driver of human development (Sen, 2001; United Nations Development Programme, 2000). Although demands-resources explanations are familiar to psychologists in various subdisciplines (e.g., Bakker & Demerouti, 2007; Bandura, 1997; Lazarus & Folkman, 1984; Skinner & Brewer, 2002), the compensation of climatic demands by wealth resources might be a too far-fetched application. Do objective demands and resources usually elicit awareness of subjective threats and challenges? A more realistic tenet is that both non-conscious and conscious appraisals of the climatoeconomic environment elicit goal-directed responses to survive and thrive. This tenet will not be tested here. Our preliminary empirical explorations of the ecological explanation leave the awareness of compensation of climatic demands by wealth resources for experimental studies.

Evolutionary explanation

The livability of the local environment is more than a matter of geography (latitude and longitude) and ecology (demands and resources). One branch of evolutionary thinking, life-history theory (e.g., Chisholm, 1999; Ellis, Figueredo, Brumbach, & Schlomer, 2009; Griskevicius, Tybur, Delton, & Robertson, 2011; Kaplan & Gangestad, 2005), highlights that in different phases of life (a) time, effort, and other resources have to be allocated across distinct fitness-relevant activities; (b) environmental conditions influence trade-offs between investments in immediate versus delayed reproduction and higher-quantity versus higher-quality offspring; and (c) dangerous and unpredictable environments decrease life expectancy and promote fast life strategies characterized by a weaker future orientation and weaker self-control, more aggression, and less cooperation, whereas safe and predictable environments increase life expectancy and promote slow life strategies characterized by a stronger future orientation and stronger self-control, less aggression, and more cooperation.

Latitudinal psychology is thought to benefit most from an integration of spatial and temporal explanations. As a case in point, a new model of climate, aggression, and self-control in humans (CLASH; Van Lange et al., 2017a) posits that lower temperatures and larger variations in temperature at higher latitudes

covary with slower life strategies and less aggression and violence. Specifically, CLASH hypothesizes that stronger future orientation and greater self-control at higher latitudes mediate the impact of colder winters and greater seasonality on lower levels of aggressive harassment, violent crime, homicide, and political violence. By implication, the inverse hypothesis applies to the approximate opposites of aggression, including trustful cooperation and joint creativity. The CLASH model further extends life-history theory by distinguishing between self-control in the sense of self-regulation and control over environmental stress—a topic to which we turn next.

Contemporary explanation

According to the compensatory-control theory (e.g., Friesen, Kay, Eibach, & Galinsky, 2014; Landau, Kay, & Whitson, 2015; Whitson & Galinsky, 2008), people facing stressful environments that reduce control respond with compensatory strategies for restoring perceived control to baseline levels. There are several ways in which reduced control over the climatic environment can be restored through either internal or external strategies using either agency or structure as a compensatory pathway. Control can be restored by using one's own abilities and resources, such as buying heat or cold, food and drink, cure and care (*internal agency*); seeking help from outside entities such as friends, the local community, or the government (*external agency*); seeking clear and reliable contingencies between particular actions and expected outcomes related to climate, such as helping to improve the system of irrigation or drainage (*internal structure*); and nonconsciously adopting simple, coherent, and consistent interpretations of the environment that are unrelated to climate, such as going along with an autocratic regime that clarifies and enforces rules and roles and offers stability (*external structure*).

The geographical explanation suggests the untested hypothesis that the prevalence of these compensatory-control strategies varies with latitude north and south of the equator but not with longitude east and west of the Greenwich meridian. Climatoeconomic theorizing (Van de Vliert, 2009, 2013a) seems to further suggest that the availability of compensating wealth resources, be it liquid cash or illiquid capital, may play a key role in adopting internal rather than external compensatory strategies. Rich people can usually manage control-reducing climatic demands themselves by acquiring goods or services and structuring relevant systems, whereas poor people often have little choice but to fall back on external agencies and extraneous structures. This vantage point implies that the impact of the

climatic environment on psychobehavioral functioning may considerably differ for rich versus poor individuals and collectives embracing internal versus external strategies for restoring perceived control.

Operationalizing Latitudinality in Human Functioning

It is difficult to say anything psychologically generalizable about inhabitants of northern versus southern states, provinces, or cities without specifying the continent or another geographic point or line of reference. The common method uses absolute latitudinal distance, either to the equator or between northern and southern locations, as a variable for studying cultural differences (e.g., Andersen, Lustig, & Andersen, 1990; Hofstede, 2001; Jonason & Schmitt, 2017; Nisbett & Cohen, 1996; Ronen & Shenkar, 2017; Roscoe, 2017). However, absolute latitudinal distance is an inaccurate indicator of spatial variation in psychobehavioral diversity because it overlooks important information. Latitude represents a bipolar scale with a midpoint in between two independent sets of spatial information about human functioning. Collapsing these two independent data sets treats both hemispheres as equal and neglects insightful information about differences between the two hemispheres. For example, violence and aggression are more strongly associated with greater distance to the equator in the Northern than in the Southern Hemisphere (Van de Vliert & Daan, 2017).

As a consequence, using the North and South Poles of the Earth as additional points of reference is necessary for creating real potential for the generalizability of descriptions and explanations of differences between inhabitants of northern and southern locations. To this end, we locate human habitats in terms of their geographic position on the bipolar axis ranging from the South Pole through the equator to the North Pole. We also introduce three metrics of bipolar latitudinal gradients (replicability, reversibility, and gradient strength) to more accurately position and analyze differing cultural features that characterize inhabitants of habitats located between the North and South Poles.

Latitudinal bipolarity

Geographically viewed, the equator divides the Earth into opposite hemispheres with opposite poles, whereas the Greenwich meridian divides the Earth into similar hemispheres with no poles. More ecologically viewed, the pattern of biannual increases and decreases in local solar radiation repeats itself in all hemispheres (replicability), has opposite directions on the two sides of the equator (reversibility), but does not have opposite

directions on the two sides of the Greenwich meridian (no reversibility). As a major consequence for all warm-blooded species, including humans, geographical and temporal conditions of livability and precariousness differ more along the north-south axis than along the east-west axis of the Earth—a crucial issue to which we come back later.

Locations of human habitats along the unfolded north-south axis of the Earth can best be approximated by the latitudinal position of a country's population between the equator and the nearest pole. Although national borders are imperfect cultural boundaries, they nonetheless can be fruitfully used to demark cultural units (Smith, Bond, & Kağıtçıbaşı, 2006). Bipolar latitude, ranging from 90° at the South Pole to 90° at the North Pole, is therefore used here to describe psychological indicators of national culture and ecological indicators of potential precursors. If one arbitrarily assigns negative signs to latitudes south of the equator and positive signs to latitudes north of the equator, the midrange latitudinal locations of country populations vary from -40.90 for New Zealanders to 71.71 for Greenlanders ($M = 18.89$, $SD = 24.45$; for all country scores, see Table S1 in the Supplemental Material available online; midrange latitude and longitude were retrieved from Google, 2012).

Metric foundations of latitudinal gradients

Replicability. All hemispheres of the Earth stand out as distinct natural labs for repeated studying of ecological impacts on psychological features of societal culture—the shared system of needs and stresses and embedded behavioral goals, means, and outcomes at the place of residence (Van de Vliert, 2013a, p. 468). For example, can the northern and southern labs independently confirm that poleward populations in colder climates are more concerned with punctuality, planning, and future orientation (so-called clock cultures) than populations in warmer climates toward the equator, which seem to have a stronger focus on the present and appreciation of enjoyment of events now rather than later (so-called event cultures; Levine, 2006)?

An important tool for checking the reliability of the replication is the global positioning in terms of degrees of geographic latitude of both the predictor and the predicted variable. A latitudinal gradient is considered replicable if it increases or decreases monotonically toward higher latitudes and if that change has the same direction in both the Northern and Southern Hemispheres. As an empirical case in point, the gradient of greater cultural individualism at higher latitudes, $r(51) = .79$, $p < .001$ (Hofstede, 2001, p. 519) can be repeated above

the equator, $r(40) = .80, p < .001$, and below the equator, $r(9) = .68, p = .02$.¹ Note that the interhemispheric replicability of ecological predictors and cultural features makes no assumption about whether higher latitudes indicate more northern or more southern locations.

Reversibility. Latitudinal bipolarity introduces the axiom that higher latitudes indicate more northern locations above the equator but more southern locations below the equator. Consequently, climate-induced, economic, and cultural differences between north and south are valid research parameters to the extent that they form opposite north-south gradients on the two sides of the equatorial divide. For any given variable, the presence of reversal of its north-south gradient at the equator (as a sign of convergent validity) is accentuated by the absence of reversal of its east-west gradient at the Greenwich meridian (as a sign of discriminant validity).

The proper definition of reversibility is that a north-south gradient increases or decreases monotonically toward more northern latitudes in the Northern Hemisphere but changes to the opposite direction in the Southern Hemisphere. The latitudinal gradient of smaller power differences between higher-ups and lower-downs in organizations at larger distances from the equator, $r(51) = -.68, p < .001$ (Hofstede, 2001, p. 519) provides a telling illustration. Whereas power differences decrease toward the north in the Northern Hemisphere, $r(40) = -.72, p < .001$, they increase toward the north in the Southern Hemisphere, $r(9) = .82, p < .01$. This indication of convergent validity is accentuated by discriminant validity—the absence of significant links between power differences and longitude in the Eastern Hemisphere, $r(31) = .23, n.s.$, and the Western Hemisphere, $r(18) = -.25, n.s.$ ¹ Reversibility hints at the description of a near-equatorial reversal point,² which can be computed by regressing a cultural feature—or an ecological predictor—on the unfolded north-south axis of the Earth.³

Gradient strength. Replication and reversal refer to the presence versus absence of monotonic relationships of a cultural feature or ecological predictor with latitude in the Northern and Southern Hemispheres. Gradient strength is a clearly distinct construct in several respects. First, gradient strength is defined as the degree of relationship with latitude, varying from 0 to 1. Second, the mutually independent degrees of relationship with latitude above and below the equator jointly determine the degree of replicability and reversibility of a cultural feature or ecological predictor. And as conveyed by the term gradient strength, the relationships generally show the similarities and differences in the steepness of the latitudinal slopes between the two hemispheres. Finally, and

perhaps most importantly for the purposes of the current analysis, the coefficient for the worldwide degree of relationship with latitude can be calculated in two ways: uncorrected and corrected gradient strength.

The strength of a cultural or ecological gradient is commonly computed as the steepness of the latitudinal trend for absolute distance from the equator (e.g., Hofstede, 2001; Jonason & Schmitt, 2017; Ronen & Shenkar, 2017; Roscoe, 2017). This uncorrected coefficient for latitudinality produces biased estimates—either underestimations or overestimations—if there is an overrepresentation of Northern Hemisphere countries, which usually is the case. In addition, uncorrected gradient strength neglects differences in cooling and heating rates due to the larger and latitudinally longer landmass in the Northern compared with the Southern Hemisphere. Corrected gradient strength is computed as the average steepness of the two latitudinal trends in the Northern and Southern Hemispheres.

As an illustration, take the case of cultural individualism in the precolonial and preindustrial societies of the Old World, to which we come back later. The uncorrected gradient strength of individualism across Old World countries from both hemispheres, $r(143) = .36, p < .001$, underestimates the strength of the reversible north-south trend for reasons related to the larger sample size and weaker latitudinal correlation in the Northern Hemisphere, $r(120) = .35, p < .001$, compared with the Southern Hemisphere, $r(21) = .50, p < .01$. The corrected gradient strength, $(.35 + .50)/2 = .425$, overcomes these drawbacks by separately accounting for the values of the Northern Hemisphere correlation and the Southern Hemisphere correlation between individualism and latitudinal distance from the equator.⁴

Testing Latitudinality in Human Functioning

Sampling cultural features

As outlined above, latitudinal psychology provides the building blocks for developing critical hypotheses that should preferably be tested under controlled circumstances. To further facilitate this process, we next present some analyses of publicly available cross-cultural data on key topics in psychological science. To adequately represent the latitudinal bipolarity of the Earth, we sampled only mental and behavioral phenomena with more than 100 country-level data points, including at least 20 countries from the Southern Hemisphere. The low numbers of Southern Hemisphere countries allow for preliminary replication tests of latitudinal gradients of mind-sets and behavioral habits observed in the Northern Hemisphere—tests that inform and direct

Table 2. Interrelations Among Six Features of Culture in the Northern Hemisphere (Above the Diagonal) and Southern Hemisphere (Below the Diagonal)

Cultural features	1	2	3	4	5	6
1. Creativity	—	-.72	.65	.45	.60	.25
2. Aggressiveness	-.68	—	-.45	-.39	-.40	.02
3. Life satisfaction	.70	-.53	—	.50	.44	.09
4. Individualism	.73	-.42	.78	—	.24	.18
5. Trust	.56	-.65	.35	.35	—	.11
6. Suicidality	-.29	.06	-.41	-.10	-.08	—

Note: Boldface type indicates statistically significant correlations ($p < .05$).

The positive metacorrelation between the 15 intercorrelations in the Northern Hemisphere and the 15 intercorrelations in the Southern Hemisphere ($r = .89$, $p < .001$) indicates that country populations on both sides of the equator tend to conceptualize culture equivalently in terms of a broad nomological network of cultural features. The number of Northern Hemisphere countries over which the correlations are calculated varies from 78 to 130; unidimensionality of culture (Cronbach's $\alpha = .44$) is most clearly disconfirmed by suicidality ($|\text{mean } r| = .37$; $|SD \text{ for } r| = .21$). The number of Southern Hemisphere countries over which the correlations are calculated varies from 12 to 33; unidimensionality of culture cannot be reliably computed because data on all cultural features are available for only nine countries.

future research possibilities. Another sampling decision turns the measurement weakness of large standard deviations around the mean into an inferential strength: We retained nine large countries that span multiple latitudes and are home to subpopulations with differing identities (Argentina, Australia, Brazil, Canada, Chile, China, India, Russia, and the United States).

On the basis of these sampling decisions, we included measures of creativity, aggressiveness, life satisfaction, individualism, trust, and suicidality (sources and measures are detailed in Table S2 in the Supplemental Material). Although this convenience sample of psychological features of culture is certainly not representative of all imaginable features, it seems to adequately highlight some widely differing components of culturally shared mind-sets and behavioral habits that are measured in a variety of obtrusive and unobtrusive ways and cut across various subdisciplines of psychology. The country scores of the six cultural features are provided in Table S1 of the Supplemental Material. Table 2 reports interrelations, measurement equivalence across hemispheres, and tentative evidence for the multidimensionality of those objective and subjective features of national culture.

Latitudinal gradients of cultural features

The replicability, reversibility, and gradient strength of the sampled spatial distributions of culture are discussed here in the overall order of decreasing latitudinality and decreasing support for the geographical

explanation. Most attention is given to the near-equatorial reversals of the north-south gradients (indicating convergent validity) against the background of missing associations with longitude on both sides of the Greenwich meridian (indicating discriminant validity).

Creativity. We used a cross-national index of invention and innovation (Murray, 2014; Van de Vliert & Murray, 2018) that integrates standardized obtrusive and unobtrusive scores of (a) Cornell University's global innovation index ($n = 140$); (b) the technology achievement index of the United Nations ($n = 68$); (c) the World Economic Forum's survey assessment of perceived creative capacity ($n = 141$); (d) the log-transformed rate of patent applications per country reported by the World Intellectual Property Organization ($n = 87$); and (e) Nobel Prize laureates per capita, by country of birth, log-transformed after adding 1 to reduce skewness ($n = 155$; Cronbach's $\alpha = .95$).

Across 155 countries, the average levels of creativity shown in Table S1 in the Supplemental Material appear to represent replicable latitudinal gradients of creativity in the Northern Hemisphere, $r(123) = .64$, $p < .001$ (Table 3), and the Southern Hemisphere, $r(28) = .56$, $p < .001$. In addition, as can be seen in Figure 1, the north-south gradient reverses its direction at $0^{\circ}36'N$, which results in $r(123) = .64$ and $p < .001$ in the Northern Hemisphere (same sign) but $r(28) = -.56$ and $p < .001$ in the Southern Hemisphere (reversed sign). Figure 2 shows a clear pattern, with Singapore as the only outlier. Compared with southerners, northerners tend

Table 3. Metric Properties of Latitudinal Gradients of Cultural Features

Cultural features	Replicability		Gradient strength	
	Northern gradient	Southern gradient	Uncorrected	Corrected
Creativity	$r(123) = .64^{***}$	$r(28) = .56^{**}$	$r(153) = .65^{***}$.600
Aggressiveness	$r(130) = -.53^{***}$	$r(33) = -.42^{**}$	$r(165) = -.50^{***}$.475
Life satisfaction	$r(115) = .37^{***}$	$r(24) = .54^{***}$	$r(141) = .42^{***}$.455
Individualism	$r(120) = .35^{***}$	$r(21) = .50^{**}$	$r(143) = .36^{***}$.425
Trust	$r(90) = .46^{***}$	$r(20) = .35$	$r(112) = .48^{***}$	Unreliable
Suicidality	$r(133) = .21^*$	$r(33) = .21$	$r(168) = .10$	Unreliable

Note: Replicability exists if a feature of culture is positively or negatively related to midrange latitude in both the Northern and Southern Hemispheres. Gradient strength is the size of the relationship between a cultural feature and midrange latitude. Uncorrected strength refers to the relationship with absolute latitudinal distance from the equator. Corrected strength refers to the average of the latitudinal gradients in the Northern and Southern Hemispheres.

* $p < .05$. ** $p < .01$. *** $p < .001$.

to be more inventive and innovative in the Northern Hemisphere but less inventive and innovative in the Southern Hemisphere. By contrast, and indicating discriminant validity, easterners are not more or less creative than westerners regardless of whether they reside east, $r(107) = -.04$, n.s., or west, $r(44) = .03$, n.s., of the Greenwich meridian.

Aggressiveness. One might think that some people fight in response to conflict whereas others seek a peaceful solution. However, it has been shown that fighting and creative problem-solving are not necessarily mutually exclusive modes of conflict management (Van de Vliert, 1997). As a consequence, the latitudinality of creativity does not necessarily imply latitudinality of hostility. The previously discussed CLASH model (Van Lange et al., 2017a) postulates that aggression and violence increase as one moves closer to the equator. To test this latitudinal prediction, Van de Vliert and Daan (2017) averaged three national measures of aggressiveness: the 2010 index of domestic warfare and violence ($n = 146$), mean press repression from 2005 to 2007 using the square root to reduce skewness ($n = 160$), and reported business costs of aggressive crime and violence ($n = 128$; World Economic Forum, 2007; $M = 0.05$, $SD = 0.82$; Cronbach's $\alpha = .70$).

Here, we reinterpret and refine the findings from Van de Vliert and Daan (2017) in terms of the replicability, reversibility, and gradient strength of the latitudinality of violent aggression. Table 3 and Figure 1 not only confirm the CLASH prediction but also refine existing knowledge about the distribution of aggression and violence between the North and South Poles. Above $4^{\circ}59'N$, $r(130) = -.53$, $p < .001$, for both the latitudinal and north-south gradients (northerners are less aggressive than southerners). Below $4^{\circ}59'N$, the latitudinal gradient, $r(33) = -.42$, $p < .01$, and north-south gradient,

$r(33) = .42$, $p < .01$, have opposite signs (northerners are more aggressive than southerners). Although some populations are exceptionally aggressive, they cannot be held accountable for the curvilinear scatter shown in Figure 3. The discriminant validity of this latitudinal distribution is apparent from the absence of a replicable link between longitude and aggressiveness in the Eastern Hemisphere, $r(119) = .12$, n.s., and Western Hemisphere, $r(44) = -.34$, $p < .05$.

Life satisfaction. How do inhabitants of northern locations differ from inhabitants of southern locations when it comes to overall life satisfaction or happiness? The

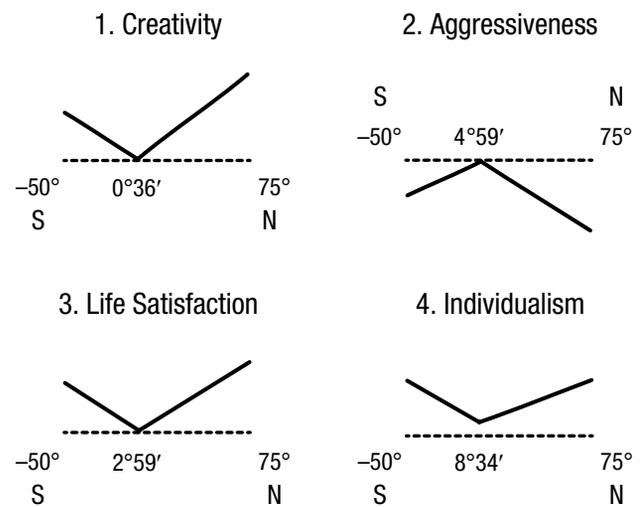


Fig. 1. Latitudinal gradients of four cultural features in the Northern (N) and Southern (S) Hemispheres. Steeper upward-sloping regression lines indicate stronger positive links with latitude; steeper downward slopes indicate stronger negative links with latitude (Table 3). All regression lines extend from a near-equatorial reversal point (see Notes 2 and 3).

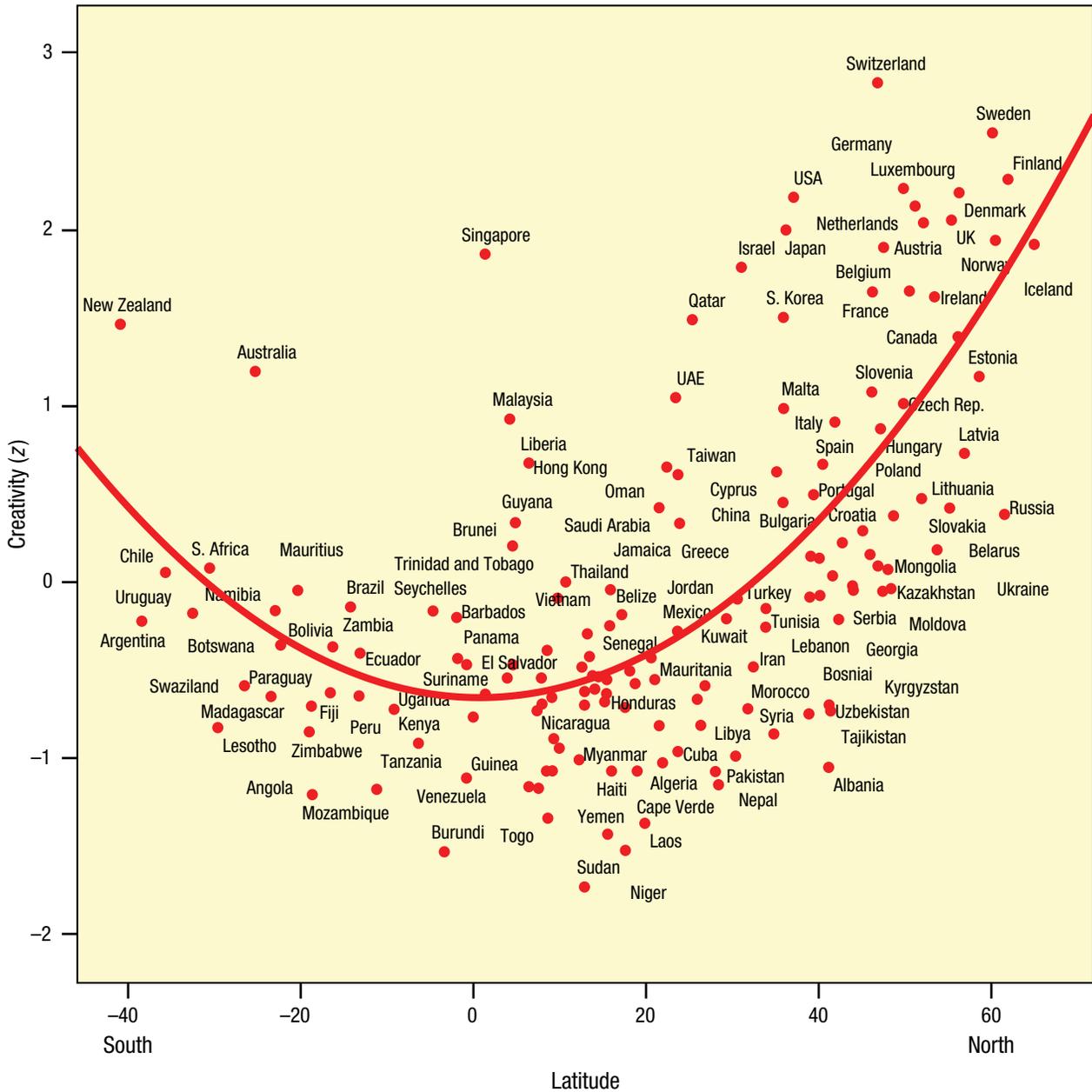


Fig. 2. Latitudinal distribution of creativity. Scatterplot (with best-fitting regression line) shows the relationship between latitude of residence and creativity. Each dot represents a country's population.

Gallup World Poll uses the following self-anchoring striving scale to measure cross-national differences in subjective well-being:

Please imagine a ladder with steps numbered from zero at the bottom to 10 at the top. The top of the ladder represents the best possible life for you and the bottom of the ladder represents the worst possible life for you. On which step of the ladder would you say you personally feel you stand at this time? On which step do you think you will

stand about five years from now? (Gallup, 2011, para. 3)

Because the present and future ratings appear to tap a common dimension, the United Nations has aggregated these two individual-level ratings into a country-level evaluation of life satisfaction or happiness (United Nations Development Programme, 2010; $n = 143$; $M = 5.84$, $SD = 1.40$).

This prevalence of collective life satisfaction can also be described spatially in relation to the equator and the

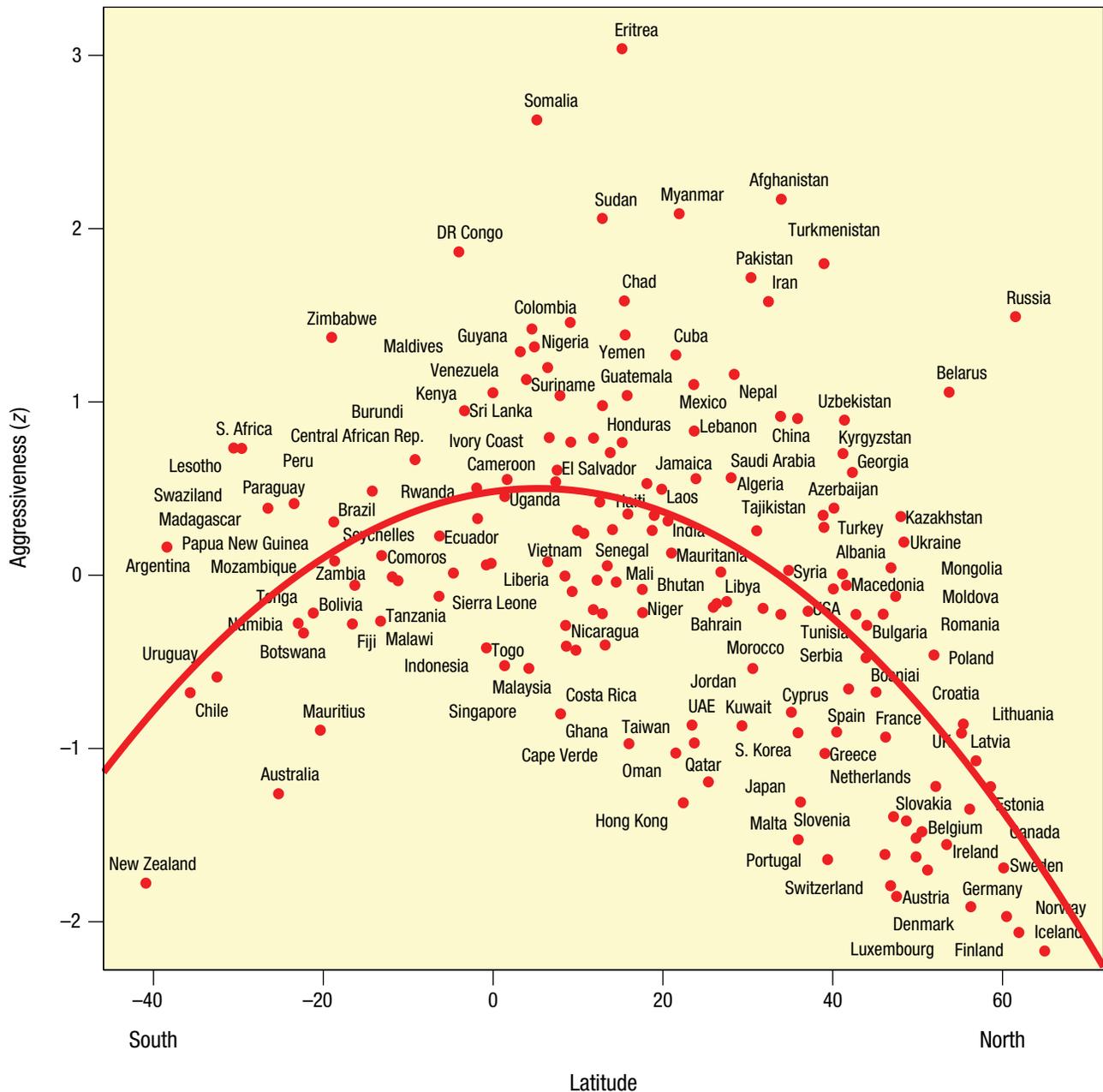


Fig. 3. Latitudinal distribution of aggressiveness. Scatterplot (with best-fitting regression line) shows the relationship between latitude of residence and aggressiveness. Each dot represents a country's population.

poles, $R^2 = .18, p < .001$. Northerners, more so than southerners, say they are satisfied with their lives if they live in the Northern Hemisphere, $r(115) = .37, p < .001$. By contrast, southerners are more satisfied with their lives than northerners if they live in the Southern Hemisphere, $r(24) = .54, p < .001$. It is unlikely that the coefficients shown in Table 3, the near-equatorial reversal point shown in Figure 1 ($2^{\circ}59'N$), and the U-curved scatter of countries shown in Figure 4 rest on coincidence or on a mysterious bipolarized field of response

falsification. Rather, latitude-related conditions are probably accountable for this equatorial trough of feelings of dissatisfaction with life and general unhappiness. This impression is strengthened by inconsistent variations of life satisfaction along longitude east, $r(102) = .15, n.s.$, and west, $r(37) = .58, p < .001$, of the Greenwich meridian.

Individualism. Culturally shared identity has hidden traces from precolonial and preindustrial times, some of

Table 4. Metric Properties of Latitudinal Gradients of Ecological Predictors

Ecological predictors	Replicability		Gradient strength	
	Northern gradient	Southern gradient	Uncorrected	Corrected
Climatic predictors				
Total thermal demands	$r(173) = .86^{***}$	$r(54) = .64^{***}$	$r(229) = .85^{***}$.750
Cold demands	$r(173) = .91^{***}$	$r(54) = .66^{***}$	$r(229) = .89^{***}$.785
Heat demands	$r(173) = -.60^{***}$	$r(54) = -.22$	$r(229) = -.51^{***}$	Unreliable
Steady rain	$r(173) = .52^{***}$	$r(54) = .28^*$	$r(229) = .44^{***}$.400
Intermediate predictors				
Pathogen prevalence	$r(165) = -.64^{***}$	$r(50) = -.43^{***}$	$r(217) = -.59^{***}$.535
National wealth (ln)	$r(141) = .51^{***}$	$r(36) = .57^{***}$	$r(179) = .54^{***}$.540
Population density (ln)	$r(173) = -.02$	$r(54) = -.43^{***}$	$r(229) = -.01$	Unreliable
Income inequality	$r(98) = -.66^{***}$	$r(24) = .39^*$	$r(124) = -.53^{***}$	Unreliable

Note: Replicability exists if a predictor is positively or negatively related to midrange latitude in both the Northern and Southern Hemisphere. Gradient strength is the size of the relationship between a predictor and midrange latitude. Uncorrected strength refers to the relationship with absolute latitudinal distance from the equator. Corrected strength refers to the average of the latitudinal gradients in the Northern and Southern Hemispheres.

* $p < .05$. ** $p < .01$. *** $p < .001$.

which may not be coverable by linguistic analysis. The cultural heritage of individualism has notably left its unobtrusive mark on different languages to different degrees. Indeed, the frequency of using subject pronouns such as *I*, *you*, and *he/she* is characteristic of populations with a history of individualism (Kashima & Kashima, 2003; Na & Choi, 2009). Using the World Atlas of Language Structures Online (<http://wals.info>), Meyer-Schwarzenberger (2015) constructed a comprehensive index measuring the degree to which individual agency has historically been accentuated. “Bill dropped the pen,” for example, would be coded as an indication of individualism because a causal agent can be identified, whereas “The pen dropped” would be coded as an indication of contextualization characterized by an external attribution of responsibility. Altogether, this individualism index integrates six such linguistic features of subject prominence in 85 languages spoken by a majority of inhabitants in 145 countries ($M = 0.49$, $SD = 0.31$).

Linguistic individualism is basically a centuries-old manifestation of viewing the self as unique and autonomous, for which Markus and Kitayama (1991, 2010) have coined the term *independent self-construal*. Meyer-Schwarzenberger’s linguistic individualism is a relatively stable and unobtrusive measure that, in combination with latitudinal place of residence, provides valuable historic information about local life in precolonial and preindustrial times. The information in Table 3, geometrically pictured in Figure 1 and plotted in Figure 5, reveals a downward southern gradient of individualism that turns into an upward northern gradient of individualism at 8°34’N of the equator. In the Northern and Southern Hemispheres, the respective latitudinal

gradients are $r(120) = .35$, $p < .001$, and $r(21) = .50$, $p < .01$. In the end, these results intriguingly imply that northerners in opposite latitudinal hemispheres have opposite histories of creating independent self-construals. The same holds true for southerners in opposite latitudinal hemispheres. However, at least since the eve of the colonial era, easterners and westerners have differed little from each other in individualism—east of Greenwich: $r(92) = -.22$, $p < .05$; west of Greenwich: $r(49) = .03$, n.s.

Trust. Believing that other people are honest and have no intention of harming you endows the trust-senders as well as the trust-receivers with social capital (Fukuyama, 1995; Herreros, 2004; Welzel & Delhey, 2015). “Social capital increases as the radius of trust widens to encompass a larger number of people and social networks among whom norms of generalized reciprocity are operative” (Realo, Allik, & Greenfield, 2008, p. 447). Generalized trust—and social capital in its wake—may be considered a societal asset that can help manage numerous stressors of daily life in markets, organizations, groups, and dyads (Kong, 2013); it is “the bedrock of cooperation” (Nannestad, 2008, p. 428; see also Balliet & Van Lange, 2013; Colquitt, LePine, Piccolo, Zapata, & Rich, 2012).

The most comprehensive cross-national study on trust to date (Robbins, 2015) included representative data from 123 populations spread over a 29-year time period. Trust was expressed as the percentage of a country’s population answering “most people can be trusted” to the question, “Generally speaking, would



Fig. 4. Latitudinal distribution of life satisfaction. Scatterplot (with best-fitting regression line) shows the relationship between latitude of residence and life satisfaction. Each dot represents a country’s population.

you say that most people can be trusted or that you need to be very careful in dealing with people?” ($M = 26.01, SD = 15.29$). Impressively, Robbins (2015) found that 86% of the variation in trust is due to between-country factors. Such large between-country differences may reflect climatic, economic, or political influences, but the bigger picture for understanding these differences has yet to be provided. Past research has suggested that general trust has relatively little heritability and that the local environment, perhaps in combination with relatively recent social experiences, may be

essential for the development of low versus high trust (for a review, see Van Lange, 2015). But interestingly, in the voluminous literature on trust, the possibility of latitudinal variation in trust was not mentioned—let alone analyzed.

Our spatial reanalysis of Robbins’s data, reported in Table 3 and plotted in Figure S1 in the Supplemental Material, brings to light higher trust at higher latitudes, $r(112) = .48, p < .001$, but not at higher longitudes, $r(81) = .08, n.s.$, in the Eastern Hemisphere, and $r(29) = -.12, n.s.$, in the Western Hemisphere. Importantly, the

(Davis & Lowell, 2002; Lester, 1986; Van der Linden, 2017), even after controlling for winter cold, summer heat, and their interseasonal interaction (Van de Vliert, 2009). However, the most recent and extensive suicide data released by the World Health Organization (2014; log-transformed to reduce skewness; $M = 2.16$, $SD = 0.66$) reveals that this conventional knowledge needs to be reconsidered because even the uncorrected gradient strength of suicidality does not reach significance, $r(168) = .10$, $p = .17$ (Table 3); $r(133) = .21$, $p < .05$, in the Northern Hemisphere, and $r(33) = .21$, $p = .22$, in the Southern Hemisphere.

Figure S2 in the Supplemental Material shows in more detail that suicide rates tend to be minimal at moderately high latitudes in the Northern Hemispheres but maximal at moderately high latitudes in the Southern Hemisphere. A regression analysis reveals that linear latitude, $\beta(168) = -0.44$, $p < .01$, latitude squared, $\beta(168) = 0.41$, $p < .001$, and latitude cubed, $\beta(168) = 0.60$, $p < .001$, account for 15% of the variation in suicide. This cubic distribution of suicidality between the North and South Poles poses a mystery that awaits exploration by clinical psychologists. They can leave east-west differences out of consideration because easterners are not more or less suicide-prone than westerners in either the Eastern Hemisphere, $r(121) = .07$, n.s., or the Western Hemisphere, $r(45) = -.13$, n.s.

Improving Latitude-Related Explanations of Cultural Features

The reported correlational results tentatively support the idea that human functioning—at least for creativity, aggressiveness, life satisfaction, and individualism—varies along latitude rather than longitude and in opposite directions above and below the equator. Recall that the same pattern of results has been observed for in-group favoritism, out-group rejection, political oppression, legal discrimination, and communication bullying (Van de Vliert & Conway, 2019). Taken together, there is considerable evidence in favor of the psychological tenet outlined in Table 1 that inhabitants' habits are dependent on habitat location. Although this geographical explanation is general in terms of ultimate origins (the Sun's radiation and the Earth's rotation) and parsimonious in terms of geography (north-south differences dwarf east-west differences), it falls short on the scientific requirement of accuracy (by specifying mediating and modifying mechanisms; Van Lange, 2013; Weick, 1979). Thus, there is a need for developing interdisciplinary research efforts into the processual connections between latitude-related conditions and culture-related psychology.

It is clearly too premature to already complement the geographical explanation with a process theory that accounts for one or more cultural aspects of psychology. The systematic and robust nature of the reported results does, however, enable the formulation of two criteria to be met by any valid explanation of latitude-related features of psychobehavioral functioning. First, a cultural feature with oppositely sloping north-south gradients above and below the equator must be explained by factors that also have oppositely sloping north-south gradients above and below the equator (compatibility of convergent validity). Second, a cultural feature varying by latitude and not by longitude must be explained by factors that also vary by latitude and not by longitude (compatibility of discriminant validity). Strict adherence to these criteria will prevent the development of questionable explanations of latitude-related mind-sets or behavioral habits. For example, the first criterion of compatibility of convergent validity will help prevent violating the statistical assumption of independent observations, whereas the second criterion of compatibility of discriminant validity will help prevent east-west confounds of north-south differences.

Most notably, the two criteria for developing valid explanations may help upgrade suboptimal accounts of latitudinal gradients in cultural and psychological phenomena. Theories about how culture is influenced by colonization (e.g., Acemoglu, Johnson, & Robinson, 2001; Acemoglu & Robinson, 2012; Lange, 2004; Welzel, 2013) and migration (e.g., House, Hanges, Javidan, Dorfman, & Gupta, 2004; Ronen & Shenkar, 2013, 2017) are cases in point. These frameworks make use of climatic, pathogenic, demographic, and economic factors without anchoring these predictors to the coordinates of latitude (no convergent validity) and longitude (no discriminant validity). We describe these factors in detail below and examine to what extent they meet the two criteria for contributing to valid explanations within latitudinal psychology. Included are six factors that are subdivided into remote climatic predictors (thermal demands and steady rain) and intermediary predictors (pathogen prevalence, national wealth, population density, and income inequality).

Climatic predictors

Thermal demands. Climates with temperate seasons are relatively undemanding by offering pleasant temperatures, abundant nutritional resources owing to the rich flora and fauna, and relatively healthy habitats. But colder winters and hotter summers require more and better clothing, shelter structures, warming or cooling systems, and increasing investments of time and effort in the

pursuit of water, food, and health. Because acclimatization has negligible compensating effects (Parsons, 2003), more and more measures have to be taken in increasingly colder or hotter conditions, especially during bitter winters or scorching summers, to safeguard subsistence and societal sustainability.

Indeed, although it is common to use the mean level of temperature as a predictor of human conflict (e.g., Hsiang, Burke, & Miguel, 2013) and other cultural features (Carleton & Hsiang, 2016; De Dreu & Van Dijk, 2018; Georgas, Van de Vijver, & Berry, 2004; House et al., 2004), temperature variations should also be important remote predictors of culture. Average temperature is an inaccurate determinant because it ignores the bipolarity of thermal livability. Clearly, 4 °C and 40 °C both pose existential problems, so that larger seasonal variations around the same mild average temperature have larger impacts on human functioning. Higher latitudes also have both lower averages and larger seasonal variations in temperature (Van Lange et al., 2017a). These shortcomings of average temperature as a predictor of culture can be overcome by concentrating on temperature deviations from a thermal optimum.

Physiological (Parsons, 2003), psychological (Fischer & Van de Vliert, 2011; Van de Vliert, 2009), and agricultural (Cline, 2007; Mendelsohn & Schlesinger, 1999) evidence suggests that human livability is optimal in the range between 17 °C and 27 °C. This has led to the development of a thermometer that uses 22 °C (approximately 72 °F) as an approximate midpoint of that reference interval for livability (Van de Vliert, 2017). Demanding temperature extremes are measured accordingly as the mean deviation from 22 °C for the average (a) lowest temperature in the coldest month, (b) highest temperature in the coldest month, (c) lowest temperature in the hottest month, and (d) highest temperature in the hottest month.⁵ Indices for cold and heat deviations from 22 °C, and for total temperature deviations from 22 °C, are available for 231 independent countries and dependent territories (Van de Vliert, 2013b; total thermal demands are reproduced in Table S1 in the Supplemental Material).

These indices reveal that the present-day Earth offers larger cold deviations from 22 °C ($M = 30.94$, $SD = 25.97$) than heat deviations from 22 °C ($M = 21.28$, $SD = 7.61$); $t(229) = 4.75$, $p < .001$. Our bipolar perspective further reveals that total thermal demands and cold demands possess excellent replicability, reversibility, and gradient strength of latitudinality, whereas heat demands are an exception to this rule (Table 4). Heat demands miss opposite north-south gradients above and below the equator, thus offering no opportunity to validly investigate the interactive impact of cold and heat demands on latitudinal gradients of culture. The

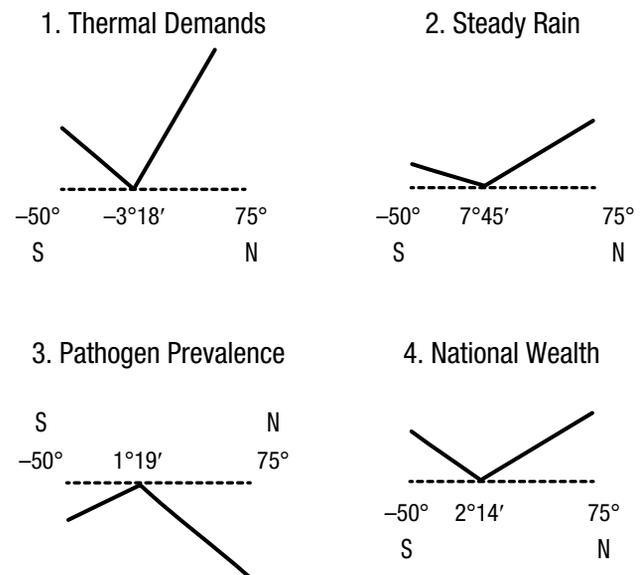


Fig. 6. Latitudinal gradients of four ecological predictors in the Northern (N) and Southern (S) hemispheres. Steeper upward-sloping regression lines indicate stronger positive links with latitude; steeper downward slopes indicate stronger negative links with latitude (Table 4). All regression lines extend from a near-equatorial reversal point (see Notes 2 and 3). Detailed scatter plots with country labels are included as Figures S3 to S6 in the Supplemental Material.

additive measure of total thermal demands, however, may potentially contribute to valid explanations within latitudinal psychology because of its opposite north-south gradients above and below the equator (Fig. 6; plotted in Fig. S3 in the Supplemental Material) and its inconsistent gradients along longitude east, $r(145) = -.37$, $p < .001$, and west, $r(82) = .36$, $p < .001$, of the Greenwich meridian.

Steady rain. Every community on Earth depends on water supplies for daily drink and food, hygiene, and economic production. Water is such a vital resource that dry seasons constitute an ecological threat to subsistence and livability. Too much rain or snow, on the other hand, causes flooding and landslides. Given that both overly dry and overly wet periods in a year are stressful, it is surprising that scholars tend to relate mean levels of precipitation to culture (e.g., Georgas et al., 2004; Hsiang et al., 2013; Van de Vliert & Tol, 2014; Welzel, 2013). A more sensible approach is to focus on steady rain—neither too low nor too high levels of precipitation throughout the year.

Rain falling on a country has a steadier rhythm to the extent that the monthly precipitation is constant and can therefore be measured as the minimal monthly precipitation divided by the maximal monthly precipitation (retrieved from Parker, 1997, and reproduced in Table S1 in the Supplemental Material; $M = 0.20$,

$SD = 0.20$). The replicability, reversibility, and gradient strength of the latitudinal variation in steady rain are satisfactory (Table 4, Fig. 6, and Fig. S4 in the Supplemental Material): $r(173) = .52, p < .001$, in the Northern Hemisphere, where more northern populations get more steady rain, and $r(54) = .28, p < .05$, in the Southern Hemisphere, where more southern populations get more steady rain. The decision to replace mean levels of precipitation with steady rain is far from trivial because the two predictors are unrelated, $r(145) = .07, p = .36$ in the Northern Hemisphere; $r(36) = .17, p = .30$, in the Southern Hemisphere, indicating that steady rain does more adequately represent the reduction of both drought and deluge as threats to livability.

Steady rain possesses convergent validity because of its oppositely sloping north-south gradients on the two sides of the equatorial divide (Fig. 6) as well as discriminant validity because of its invariance along longitude on the two sides of the Greenwich meridian— $r(145) = .11$, n.s., in the Eastern Hemisphere, and $r(84) = -.06$, n.s., in the Western Hemisphere. Steady rain can play a crucial role in latitudinal psychology, as may already be apparent from its impact on the prevalence of lactose tolerance in 1500 and, through it, on empowering resources in 1800 and encultured freedoms in 2000 (Van de Vliert, Welzel, Shcherbak, Fischer, & Alexander, 2018).

Intermediate predictors

Pathogen prevalence. Human infectious diseases increase with temperature and with precipitation and may thus serve as mediating links between climatic circumstances and cultural features. There is a complication, however. The temperature-based increase in pathogen prevalence occurs only outside the tropics, whereas the precipitation-based increase in pathogen prevalence is restricted to the tropics (Cashdan, 2014). Biogeographically put, just like humans, microorganisms and parasites tend to shun both arctic and desert habitats where livability is problematic. Scholars have found that human-to-human transmitted diseases (e.g., measles, cholera, leishmaniasis, leprosy) motivate people to avoid contact with others and create social networks that are conducive to less creativity (Murray, 2014), greater aggressiveness (Thornhill & Fincher, 2011), less individualism (Fincher, Thornhill, Murray, & Schaller, 2008), and more collectivism (Fincher & Thornhill, 2012; Fincher et al., 2008).

For a long time, biogeographers have contributed important insights to the understanding of patterns of decreasing human pathogens and other taxa from the tropics to the Arctic and Antarctic—latitudinal gradients in biodiversity (Cashdan, 2001; Fincher & Thornhill, 2008; Harcourt, 2015; Rosenzweig, 1995). Cashdan (2014) has additionally shown that both the number of

human pathogens and the corresponding prevalence of infectious diseases have steeper latitudinal gradients across mainland locations with mainly continental climates than across island locations, with mostly the milder climates closer to the sea or ocean. In the terminology used here, the latitudinal decreases in pathogen prevalence have a greater uncorrected gradient strength for countries with vaster land areas.

Pathogen prevalence is a potentially relevant mediating factor, as primarily evidenced by its corrected gradient strength (Fincher & Thornhill, 2012; see Table 4 and Table S1 in the Supplemental Material), which is geometrically pictured in Figure 6 and plotted in Figure S5 in the Supplemental Material. The importance of pathogen prevalence is further marked by unsystematic variations along longitude in the Eastern Hemisphere, $r(140) = -.09$, n.s., and Western Hemisphere, $r(75) = .37, p < .001$. A final reason for why latitudinal psychology should take account of pathogen prevalence is the recent finding that both cold and hot temperatures exert indirect wealth-dependent effects on creative culture through a lower prevalence of human-to-human transmitted parasitic diseases (Van de Vliert & Murray, 2018).

National wealth. Income per head is the capacity of a country's currency to buy a given basket of basic goods and services. Income-based economic development may be seen as almost synonymous with cultural development (Inglehart & Baker, 2000; Sen, 2001; Welzel, 2013). The United Nations even calls its scale for measuring changes in economic development the human development index—a tight conglomerate of national income per head, level of education, and length of life expectancy. Because the spatial and temporal distributions of temperature extremes and precipitation extremes influence a country's standing on the human development ladder, the United Nations sees the fights against climate impacts on economy and culture as interrelated efforts (United Nations Development Programme, 2007). Actually, it sees national wealth as a causal mediator between climate and culture.

Countries at lower latitudes nowadays tend to have lower national wealth (Williamson & Moss, 1993; Zuleta, 2012). More specifically, in a hot belt several thousand kilometers in width encircling the Earth at the equator, more lower-income countries can be found than anywhere else (e.g., Nigeria, Congo, Somalia, Indonesia, Papua New Guinea). That pit of enduring poverty, known among economists as the equatorial grand canyon (Parker, 2000; Theil & Galvez, 1995), meaningfully contrasts with unsystematic variations of national wealth along longitude east, $r(124) = -.03$, n.s., and west, $r(53) = -.29, p < .001$, of the Greenwich meridian. For the average log-transformed income per head in 2000, 2002, and 2004 (United Nations Development

Programme, 2002, 2004, 2006; $M = 8.54$, $SD = 1.16$; see Table S1 in the Supplemental Material), the data in Table 4, Figure 6, and Figure S6 in the Supplemental Material confirm the location and V-shaped structure of the grand canyon. Taken together, the north-south and east-west distributions of income per head indicate that the latitudinal gradient of national wealth plays a crucial mediating role in the explanation of latitudinal gradients of cultural and psychological diversity.

Population density. The logged number of inhabitants per square kilometer (Parker, 1997; $M = 4.09$, $SD = 1.70$) might be another promising mediator variable for two reasons: First, humans tend to seek residence in temperate locations away from extreme cold and heat, with the consequence that population density is higher where climatic demands are lower (Van de Vliert, Yang, Wang, & Ren, 2013). Second, higher population densities in the years 1500 and 2000 are both associated with tighter contemporaneous cultures in which rules and norms were more clearly defined and more strictly enforced and in which deviants were met with greater suspicion and stronger attempts to bring them into line or ostracize them (Gelfand et al., 2011).

Somewhat paradoxically, in addition to having tighter cultures, inhabitants of more densely populated countries also show a host of traits corresponding to a slower life-history strategy (Sng, Neuberg, Varnum, & Kenrick, 2017). For example, they favor long-term relationships, prefer to marry later and have fewer children, and are more likely to invest in the future of their children. Notwithstanding all such connections between overcrowding and a range of cultural values and practices, present-day population density does not immediately qualify as a potentially useful predictor of latitudinal gradients of cultural and psychological diversity simply because latitudinality is not replicable and has no gradient strength whatsoever (Table 4 and Fig. S7 in the Supplemental Material).

Income inequality. The extent to which the distribution of income among individual households within a country deviates from a perfectly equal distribution is believed to be a covariate of dysfunction, including mental illness, lack of trust, and violence (Krems & Varnum, 2017; Wilkinson & Pickett, 2009). In line with this belief, income inequality (retrieved from United Nations Development Programme, 2006, and reproduced in Table S1 in the Supplemental Material; $M = 40.53$, $SD = 10.60$) is associated with less creativity, $r(120) = -.42$, $p < .001$, and greater aggressiveness, $r(124) = .38$, $p < .001$. However, income differences increase from the equator toward the South Pole, $r(24) = .39$, $p < .05$, but decrease from the equator toward the North Pole, $r(98) = -.66$, $p < .001$ (see

Table 4 and Fig. S8 in the Supplemental Material). Hence, the latitudinal gradient of income inequality is neither replicable nor reversible above and below the equator, thus making no obvious contribution to explaining north-south variations in culture and psychology.

Interacting predictors

It would be naive to assume that latitudinal gradients of thermal demands, steady rain, pathogen prevalence, and national wealth have main effects only on latitudinal gradients of cultural and psychological diversity. A more realistic assumption is that the remote impacts of thermal demands on culture are not only mediated but also modified by steady rain, pathogen prevalence, and national wealth. As a case in point, the CLASH model (Van Lange et al., 2017a, 2017b) states that average temperature and seasonal variation in temperature are important to understanding aggression and violence and that those climate effects may well be mediated and modified by other ecological variables such as pathogen prevalence and national wealth.

Proper tests of CLASH should address the near-equatorial reversals of the north-south gradients of all predictors and dependent variables. Ideally, particular attention should also be paid to near-equatorial reversals in the test results. An instructive example of how this could be done already exists. After having determined the near-equatorial reversal point of aggressiveness ($4^{\circ}59'N$), Van de Vliert and Daan (2017) regressed aggressiveness on the interaction of thermal demands and national wealth across 124 countries above $4^{\circ}59'N$ and then used the resulting equation to predict aggressiveness in 43 countries below $4^{\circ}59'N$ ($r = .44$, $p < .01$). Mirroring around that near-equatorial reversal point, Northern and Southern Hemisphere alloys of heat and poverty appear to predict aggression, although hellish heat seems to temper rather than fuel poverty-induced aggression. The added value of such near-equatorial reversals in the complex ecology of human functioning should not be underestimated, as these inverse replications represent quasi-experiments with a nonequivalent control group design (Shadish, 2000).

Exploring ecological explanations of culture

The evidence so far supports the latitudinality of creativity, aggressiveness, life satisfaction, and individualism. In an adjacent field, intergroup discrimination has been successfully predicted by thermal stress, hydraulic stress (steady rain reversed), pathogenic stress, national wealth, and the interaction of thermal stress with national wealth (Van de Vliert & Conway, 2019).

A logical next step is thus to likewise examine the ecological predictability of cultural features other than intergroup discrimination. We accordingly regressed our four reversely replicable features of culture (except individualism in the Old World) on standardized measures of thermal demands, steady rain, pathogen prevalence, and national wealth. As thermal demands are at the beginning of the possible causal chain, we also included the interactions of thermal demands with steady rain, pathogen prevalence, and national wealth. A conditional process analysis (Hayes, 2013, template 74) provided further insight into the indirect effects of thermal demands—effects mediated and modified by steady rain, pathogen prevalence, or national wealth.

Before summarizing the results, we want to point out that the analyses are informative at best with regard to the mechanisms underlying the population-level development of cultural features. Note that the analyses can provide only preliminary evidence because (a) the predictors overlap ($.08 < r < -.65$; for details, see Table S3 in the Supplemental Material), (b) the correlational outcomes do not allow causal conclusions, and (c) the regression equations violate the assumption of independent observations in cases in which small and geographically adjacent countries share similar ecological conditions. In addition, because subsistence styles such as herding versus farming (Uskül, Kitayama, & Nisbett, 2008) and rice farming versus wheat farming (Talhelm et al., 2014) also mediate the relationship between climatic predictors and cultural features, we consider these approaches as promising avenues of future studies central to latitudinal psychology.

Tables S4 to S6 of the Supplemental Material reveal that thermal demands, steady rain, pathogen prevalence, and national wealth account for at least half of the variation in creativity (77%), aggressiveness (50%), and life satisfaction (65%). Over and above the effects of these ecological predictors, linear latitude and latitude squared add only a negligible percentage to the prediction of creativity (1%), aggressiveness (1%), and life satisfaction (1%). Taken together, these figures suggest that as-yet-unknown latitude-related factors influence latitude-related culture to a trivial extent. Below we discuss the predictive power of each of the ecological conditions in Figure 6 as predictors of north-south differences in the investigated features of contemporary culture.

Thermal demands. Tables S4 to S6 in the Supplemental Material show that thermal demands do not uniquely account for variation in aggressiveness and life satisfaction. By contrast, direct effects of thermal demands, restricted to creativity, are only partially mediated by the impact of

national wealth. Thus, a remaining mystery for latitudinal psychology to solve is why extreme winters or summers or extreme variations between winters and summers, both above and below the equator, inspire and challenge people to become more creative. A developmental, if not evolutionary, hypothesis would be that seasonal problems and difficulties—how to stay comfortably warm and healthy; how to produce, acquire, and retain food; how to handle extreme weather—have required lots of novel solutions and innovations in practices and tools (for an integration of ecological and evolutionary approaches, see Varnum & Grossmann, 2017). Such creative niche construction would once again showcase that climatic determinism is a fallacy.

Steady rain. Drought and deluge as threats to livability have no significant effect on aggressiveness (see Table S5 in the Supplemental Material) and life satisfaction (see Table S6 in the Supplemental Material). However, there is one exception: Steady rain both mediates and modifies the effect of thermal demands on creativity (see Table S4 in the Supplemental Material). Simple-slope tests show that greater thermal demands are associated with higher creativity under conditions of less steady rain ($\beta = 0.34$, $p < .001$) and greater wealth ($\beta = 0.47$, $p < .001$) but not under conditions of more steady rain ($\beta = -0.07$, $p = .52$) and greater poverty ($\beta = -0.19$, $p = .07$). Explaining these patterns is exceedingly difficult. But at the very least, it seems impossible to solve this conundrum without distinguishing between cold, heat, drought, and deluge in both latitudinal hemispheres.

Pathogen prevalence. The only slight indication that the livability problems caused by microorganisms and parasites may matter over and above the problems caused by climate and wealth is a direct association between pathogen prevalence and aggressiveness ($\beta = 0.23$, $p < .01$; see Table S5 in the Supplemental Material). In contrast to earlier findings (Cashdan, 2001; Eppig, Fincher, & Thornhill, 2010; Fincher & Thornhill, 2008, 2012; Fincher et al., 2008; Murray, 2014; Schaller & Murray, 2011; Thornhill & Fincher, 2011; Van de Vliert & Murray, 2018), pathogen prevalence revealed no association with creativity (see Table S4 in the Supplemental Material) and life satisfaction (see Table S6 in the Supplemental Material). Thus, the parasite-stress theory of culture may be an important candidate in explaining variation in global aggressiveness but seems to play no strong role in accounting for other cultural features (see also Van de Vliert & Conway, 2019).

National wealth. A well-known predictor of creativity, aggressiveness, and life satisfaction is national wealth. An extra piece of information is that national wealth

mediates the effect of thermal demands on creativity and aggressiveness (see Tables S4 and S5 in the Supplemental Material). One of the most parsimonious interpretations is that economic and cultural development promote each other's growth (Inglehart & Baker, 2000; Sen, 2001; Welzel, 2013). Most importantly, given the explanatory prediction that wealth-based resources can compensate for thermal demands by turning threats into challenges, we expected to reconfirm that greater thermal demands decrease creativity and increase aggressiveness in poor populations but increase creativity and decrease aggressiveness in rich populations (Van de Vliert, 2009, 2013a; Van de Vliert & Daan, 2017). This is the case even after controlling for steady rain, pathogen prevalence, and their interactions with thermal demands (see Tables S4 and S5 in the Supplemental Material).

Conclusion. In support of the ecological explanation, climatoeconomic theorizing (Van de Vliert, 2009, 2013a) and the extended CLASH model (Van Lange et al., 2017b) can serve as tentative foundations for construing and constructing latitudinal psychology. However, this ecological perspective holds no monopoly on truth, as the results can in no way reject or undermine the explanatory relevance of life-history theory (e.g., Chisholm, 1999; Ellis et al., 2009; Griskevicius et al., 2011; Kaplan & Gangestad, 2005) and compensatory-control theory (e.g., Friesen et al., 2014; Landau et al., 2015; Whitson & Galinsky, 2008). The exposition of explanations in Table 1 is open-ended and evolving rather than fixed and closed.

Long-Term Implications for Psychology

Theoretical implications

Nowhere in psychology textbooks do we learn that northern residents differ more from southern residents in several respects than eastern residents differ from western residents. Nor are we told that northerners and southerners have much in common if they reside on different sides of the equatorial divide. The field of latitudinal psychology that we propose aims to fill these and related gaps in our knowledge for nontrivial phenomena such as creativity, aggressiveness, happiness, and individualism. For the time being, this is largely descriptive knowledge about the spatiality of people's mind-sets and behavioral habits. The only explanatory foundations are the mechanisms rooted in the Sun's radiation and the Earth's rotation captured by the bipolarity of latitude and the nonpolarity of longitude. The long-term ambition should be to complement this too general and too simplistic explanation with process theories that accurately specify mediating and modifying mechanisms between human biogeography and psychology.

The hard core of latitudinal psychology is represented by the replicability, reversibility, and gradient strength of north-south gradients in ecological and psychobehavioral diversity. Or more accurately put, latitudinal psychology seeks to draw scientific attention to the descriptive and explanatory connections between northern and southern environments on the one hand and cultural and individual mind-sets and behavioral habits on the other hand. Inevitable tools to accomplish this task are the replicability, reversibility, and gradient strengths of climatic cold and heat. This global framework is a major advance over Fathali Moghaddam's early sketch of how three groups of countries the world over differ in economic development and, correspondingly, in capacities for generating knowledge and for shaping mainstream psychology (Moghaddam, 1987).

In a similar vein, Henrich et al. (2010, p. 61) distinguish "Western, Educated, Industrialized, Rich and Democratic (WEIRD)" people from non-WEIRD people, showing that claims about psychological knowledge cannot usually be generalized across the two types of world citizens. Complementing the approaches of Moghaddam and Henrich et al., latitudinal psychology is a more continuous latitude-based mold of generalization of cultural features and of their individual and social consequences. As north and south are relative terms, both northerners and southerners at higher latitudes—who are more prone to being creative, non-aggressive, satisfied with life, and individualistic—are expected to need other psychological goods and services than northerners and southerners at lower latitudes.

Furthermore, whereas the crude typologies of world citizens concentrate on the proximate impact of wealth-based resources on how psychology is shaped in parts of planet Earth, latitudinal psychology is more inclusive in its emphasis on the remote impacts of climatic stresses to livability. The latter focus seems to make more sense because people use cash and capital to neutralize extreme temperatures, that is, to meet basic needs for thermal comfort, nutrition, and health by acquiring clothing, housing, warming and cooling devices, meals, medical cure and care, and so on (Montesquieu, 1748/1989; Parker, 2000; Rehdanz & Maddison, 2005). Robust empirical evidence (Van de Vliert, 2009, 2013a; Van de Vliert & Conway, 2019; see also Tables S4 to S6 in the Supplemental Material) confirms that monetary resources can compensate for thermal demands by turning threats into challenges and promoting cultural niche construction away from interdependent toward independent selves, away from rigidity and competition toward creativity and cooperation, and away from power distance toward interpersonal and intergroup equality.

Particularly revealing is the contrast between zooming in on north-south versus east-west differences in the field of psychology. Replicability diversity, reversibility, and gradient strength echo Jared Diamond's classic vision that human diversity is structured along the north-south rather than the east-west axis of the Earth (Diamond, 1997; for quantitative evidence, see Laitin et al., 2012; Turchin et al., 2006). As a result, our perspective of latitudinal psychology is bound to question to what extent north-south differences in ecological demands, ecological resources, and subsequent cultural adaptations compromise the findings of east-west differences in, for example, holistic versus analytic cognition (Nisbett, Peng, Choi, & Norenzayan, 2000; Nisbett, 2003), self-esteem (Spencer-Rodgers, Peng, Wang, & Hou, 2004), and happiness (Uchida & Kitayama, 2009).

The letter *W* in WEIRD echoes the following well-documented insight from the book *Why the West Rules—for Now* by Ian Morris (2011; see also Ferguson, 2011). For biological and sociological reasons, eastern and western populations are thought to have been going through the same stages of human development over the past 15,000 years, albeit not at the same time or at the same speed. If this is a valid observation, it follows that east-west differences in human functioning require temporal and historical rather than spatial and ecological explanations. Unlike northern and southern locations, eastern and western locations do not systematically differ in subsistence style, livability, and sustainability. Although the metrical properties of the north-south and east-west coordinates are identical, their psychological relevance is intriguingly different and creates a unique niche for latitudinal psychological discoveries.

Methodological implications

The key finding that north-south differences dwarf east-west differences in human functioning can be put to use in future research. The hypothesized latitudinality of a culturally shared mind-set or behavioral habit such as the bullying of individuals (Volk, 2017) or the media (Van de Vliert, 2011) can be tested against the null hypothesis of no relationship with longitude. Likewise, an observation of a latitude-related psychological link, such as the individual-level association between regional ambient temperature and human personality (Van de Vliert, 2017; Wei et al., 2017), gains in discriminant validity if it can be additionally shown that no longitude-related connection exists.

Unlike the typologies of world citizens in terms of east versus west, poor versus rich, and the like (Henrich et al., 2010; Moghaddam, 1987; Sue, 1999), latitudinal psychology provides opportunities for statistical analyses at the interval level and mathematical modeling. A

nonobvious example is the inverse connection between gradient strength toward both poles and gradient reversal near the equator. Across the reliably measured cultural features (Fig. 1) and ecological predictors (Fig. 6), steeper pairs of latitudinal gradients have their point of intersection and reversal closer to the equator, Spearman rank correlation $r(6) = -.93$, $p < .001$. This link most likely indicates that a smaller measurement error inherent to greater steepness leads to a more accurate estimate of the reversal point as being closer to the equator. If so, that puts an extra spotlight on the already salient finding that the latitudinal gradient of creativity is the only one to intersect and reverse exactly at 0° latitude.

Cross-national replicability is generally considered crucially important for steering away from producing WEIRD psychology (Arnett, 2008; Henrich et al., 2010; Moghaddam, 1987; Sue, 1999). The novel lens of latitudinal psychology adds that north-south replications are even more important than the implicitly promoted replications of Western findings in the East and that equatorial reversibility and gradient strength can serve as extra methodological tools for mapping and understanding the ecology of psychology. Indeed, the reported latitudinal gradients of creativity, aggressiveness, life satisfaction, and individualism should wake us, psychologists, up to the risk of latitude-related restrictions imposed on our knowledge base. As a rule of thumb, the risk to falsely claim generalizability of effects of investigations or interventions across states, provinces, or cities differing in distance to the equator can be estimated by the corrected gradient strength—the average of the latitudinal trends in the Northern and Southern Hemispheres.

A final methodological implication follows from the inherent limitations of correlational research. Convergent evidence for the link between ecological conditions and psychological processes can be obtained through ecological priming that brings threatening conditions of cold, heat, drought, deluge, disease, and poverty into controlled laboratory settings (Gelfand & Lun, 2013). In addition, psychological labs at different geographic locations could cooperate by studying and comparing native participants' individual-level responses. An especially informative design is one that crosses laboratories' hemispheric location (North, South) with their latitudinal location (north, south). Hemispheric location is a between-country factor. Latitudinal location, however, can also be manipulated within large countries. For instance, eight laboratories that systematically vary in hemispheric and latitudinal location could fruitfully cooperate in the following quasi-experimental fashion: a northern and southern lab within the United States, a northern and southern lab within China, a

northern and southern lab within Australia, and a northern and southern lab within Brazil.

Coda

Psychological scientists have expressed a strong commitment to move beyond Western societies, and cross-cultural psychology has emerged as a critical field in understanding human diversity around the globe. Our basic contributions to this worldwide field are several building blocks for explaining broad features such as creativity, aggressiveness, happiness, and individualism. First, we have newly developed three tools for conceptualizing and measuring north-south and east-west gradients of culture (replicability, reversibility, and gradient strength). Second, using these tools, we have discovered nontrivial features of culture to differ more along the north-south axis than along the east-west axis and in opposite north-south directions above and below the equatorial divide. Third, using the same tools, we have further learned that national wealth, and sometimes steady rain and pathogen prevalence as well, mediate and modify the remote impacts of extreme temperatures on cultural and psychological diversity. These advances underscore, as the subtitle of this article conveys, the burgeoning importance of an ecological perspective for a psychology that goes global and is challenged to explain geographic differences in culture. In other words, the light of latitudinal psychology seems to be breaking on the horizon.

Action Editor

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Supplemental Material

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Notes

1. For the hemispheric breakdowns, Spearman rank correlations instead of Pearson correlations are reported because of the small number of countries in the Southern and Western Hemispheres.

2. The near-equatorial reversal point recognizes and respects the existence of a geographical equator at 0° latitude, a meteorological equator at about 6°N, and a biological equator of seasonal human mortality at about 10°N (Aschoff, 1981).
3. The near-equatorial reversal point of a latitudinal gradient is computed as $X_m + (-b_1/2b_2)$, where X_m = the mean latitude of the sampled countries, b_1 = the regression coefficient for regressing the cultural feature or ecological predictor on bipolar latitude linear (X), and b_2 = the regression coefficient for regressing the cultural feature or ecological predictor on bipolar latitude squared (X^2).
4. Necessary conditions for computing corrected gradient strength are the replicability of the latitudinal gradient and the reversibility of the north-south gradient. Reversibility implies that the opposite north-south gradients differ not only from zero but also from each other.
5. Some scholars (e.g., Santos, Varnum, & Grossmann, 2017; Wei et al., 2017) adopted absolute deviation from 22 °C or 72 °F as an appropriate indicator of optimal livability but then used annual deviation from annual average temperature rather than seasonal deviations from seasonal average temperatures as the basis for assessing the livability of climatic environments. This procedure translates to problematic underestimations of thermal demands in countries with bitter winters and scorching summers. In a study of global increases in individualism by Santos et al. (2017), for example, the thermal demands in Canada ($Mdn = 29$ instead of $M = 105$) and Romania ($Mdn = 12$ instead of $M = 93$) are much lower than in the index used here.

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